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PRODUCT POSITIONING WITH COMPETITIVE REACTION: AN ITERATIVE CLUSTERING MODEL

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by

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Introduction

In his now classic article, Stefflre (1968) outlines a solution to the problem of new product positioning in an existing market. Briefly, his approach develops a "product space" spanned by the salient features of the product, where existing brands and customers' ideal points are plotted. By isolating regions in this space which contains ideal points but no brand, the method indicates where a potentially untapped market opportunity exists.

Although the model has been largely accepted as useful, some practical drawbacks have been noted. For example, do the dimensions reflect the actual choice influences and can they be validly and reliably measured? Can the brand be positioned accurately by a firm at a preselected corner of the market? Will the product space remain constant over time, or will customers or brands change their positions? In this paper an attempt is made to deal with the last of these problems. More specifically, the analysis to be presented below utilizes the Stefflre framework but extends it to the case where the existing brands' positions might be changing in response to the contemplated new product

introduction. Such a possibility often needs to be considered by the entering firm, in many consumer as well as industrial markets.

The Model

We assume that the Stefflre analysis has been carried to a point where we have determined the product space and the positions of competing brands and customer ideal points locations. "Our" firm is contemplating the introduction of a new brand and is basically able to position this brand at any location in the space. The question is, which location is "the best."

Clearly, we first need to define the objective(s) involved in our brand introduction. At least four different objectives can be identified. The first candidate objective is profit maximization. Here the positioning would be chosen in such a way that expected sales minus the costs of obtaining them would be maximized. A second objective might be simple sales maximization, where (at least in the initial stages) the costs of obtaining the sales are of little consequence to our firm. Third, a possible objective might be a "competitive niche" solution, where our brand will be positioned n a segment of the product space not sofar well covered by the existing brands. As mentioned, such a solution is the one most often referred to in the discussions of the Stefflre model. Finally, the entering firm might be interested in locating at a position which will yield a maximum joint profit for the existing brands augmented by the new one. It should be noted for future uses that whereas the two latter objectives explicitly takes into account competitive brands, the first two objectives do not account for competitors.

The next step is to express these objectives explicitly in terms of the product positioning. First some notation. Let x_{ki} denote the position of firm k on dimension i, and y_{ji} the ideal position of customer j on i. Let k=0,1,2, ..,K with our firm denoted by k=0, j=1,2,...,J, and i=1,2,...,I. Denote a trial location r of brand k as ${}_r\underline{s}_k = ({}_rx_{k1}\ {}_rx_{k2} \cdots {}_rx_{kI})$. If we assume that the customer will purchase the brand which most closely approximates his ideal brand, our firm would attract customer j at a trial location indexed by r only if

$$(1)\quad \min_k\ {}_rD_{kj} = \min_k\ \left(\sum_{i=1}^{I} ({}_rx_{ki} - y_{ji})^2\right)^{\frac{1}{2}}$$

occurs at k=0. The trial locations for the K competitors would here be identical to their present locations, for example. This simple Euclidean distance measure might be augmented by customer-specific weights on each dimension w_{ji} which would be proportional to the importance the customer attaches to deviations on each dimension. Similarly, brand specific factors not reflected in the product space dimensions, such as price, say, could be introduced. With ${}_rp_k$ denoting the price of brand k at (trial) location ${}_r\underline{x}_k$, the j'th customer will now be attracted to our brand only if

$$(2)\quad \min_k\ {}_rD'_{kj} = \min_k\ {}_rp_k \left(\sum_{i=1}^{I} w_{ji}\ ({}_rx_{ki} - y_{ji})^2\right)^{\frac{1}{2}}$$

occurs at k=0.

If we denote the unit sales potential to the j'th customer by s_j, and define

$$(d)\quad {}_r\delta_{oj} = \begin{cases} 1 \text{ if } \min\ {}_rD'_{kj} \text{ occurs at } k=0 \\ 0 \text{ otherwise} \end{cases},$$

we can write the total sales to our firm as

(4) $_r TR_0 = {_r P_0} \sum_{j=1}^{J} s_j \; {_r \delta_{0j}}$.

Similarly, the total sales to any one competitor k becomes

(5) $_r TR_k = {_r P_k} \sum_{j=1}^{J} s_j \; {_r \delta_{kj}}$,

k=1,2,...,K.

Turning to the cost side, we need to account for the fixed and unit variable costs incurred when maintaining a brand at a certain location $_r\underline{x}_k$. These will be denoted $_r F_k$ and $_r c_k$, respectively. In addition, for an existing brand contemplating relocation, "moving" costs are incurred. These can be seen as specific to each firm and dimension--moving along some dimensions are easier than others--and will likely be proportional to the distance moved. Accordingly, if we denote the existing location $_0\underline{x}_k$ and the unit moving costs for firm k m_{ki}, the total costs incurred can be written as

(6) $_r TC_0 = {_r F_0} + {_r c_0} \sum_{j=1}^{J} s_j \; {_r \delta_{0j}}$

for our centering firm, and

(7) $_r TC_k = {_r F_k} + {_r c_k} \sum_{j=1}^{J} s_j \; {_r \delta_{kj}} + \sum_{i=1}^{I} m_{ki} \left| {_r x_{ki}} - {_0 x_{ki}} \right|$,

for k=1,2,...,K.

We are then ready to explicitly restate the four alternative objective functions. Given the competitive and customer locations, the profit-maximization objective can be written as

(8) $\max_{r \in S} {_r P_0} = \max_{r \in S} ({_r TR_0} - {_r TC_0})$,

where it is understood that the location parameter r can vary over the whole product space S. The sales maximization objective becomes simply

$$(9) \quad \max_{r \in S} \; {}_rTR_0 .$$

The competitive niche goal can be translated into a positioning which will minimize the total distances travelled by customers, since this will tend to place our brand into an untapped segment. Thus, this objective is written as

$$(1) \quad \min_{r \in S} \; {}_rTD_0 = \min_{r \in S} \sum_{j=1}^{J} \min_{k} \; {}_rD'_{kj} ,$$

where k=0,1,2,...,K. Finally, the joint profit maximization goal can be expressed as

$$(11) \quad \max_{r \in S} \; {}_rJP_0 = \max_{r \in S} \sum_{k=0}^{K} ({}_rTR_k - {}_rTC_k) \quad .$$

The corresponding formulations for any of our K competitors are straightforward to derive.

The actual optimization of these alternative objective functions with respect to the product positioning is not easily done with analytical methods since the objective function surface contains several local optima in all the cases. Consequently, a more appropriate method to use is a search over the relevant region. In smaller problems this search can be exhaustive, simply scanning the objective function surface from a superimposed grid. This is the method followed in certain cluster analyses, and will be followed in the empirical examples given later in this paper. For larger problems such an exhaustive search becomes quite costly, and can be replaced by a suitable standard non-linear optimization search algorithm. In such large problems a very crude grid might

be used to identify a promising starting point for the algorithm--an example will be given below.[1]

It is proposed here that this framework be used to identify the best product positioning choice given a preselected objective; and that in addition, before actual entry, the model be used to predict the losses suffered by each competitor, should we enter at this best position; and further, that the model be used to predict the reactions by the competitors by (1) ascribing a particular objective to each competitor's actions, and (2) assessing the benefits of alternative competitive relocations aimed at recapturing some of the losses, and (3) predicting a most likely repositioning strategy for each competitor following our entry.

Remembering that these competitive moves only represent potential actions, we can furthermore use the model to reevaluate our initial choice, given competitors' optimal relocations, and continue another round. And so on. In some cases it is clear that an entry will

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[1]It should perhaps be noted that one way of conceptualizing our approach is to see it as a clustering approach with the usual distance functions being replaced by alternative objective functions.

It should also be pointed out that not all standard search routines are applicable here. Specifically, a routine that searches along the main axes of the product space is not appropriate, since distance measures are defined over the diagonals of the implicit triangles formed by the points. Thus, initial runs with the Hooke & Jeeves direct/search routine were fruitless, whereas the modified simplex search routine of Nelder & Mead proved quite efficient (for a discussion of these and other routines, see Himmelblau, 1972). Since the illustrations used for the paper were carried out for a two-dimensional space, a complete grid search was quite feasible and the approach used. As a "spillover" payoff from the use of a search over trial locations, management can easily evaluate several alternatives in any one run.

disrupt the existing shares to such an extent that a new equilibrium might be unobtainable. In such cases, a daring, sales-maximizing entry will lead to a high likelihood for competitive reactions, whereas a slightly more low-keyed positioning, using, say, a competitive niche criterion, would lead to little upheaval in the market, and in the long run be more advantageous to all parties. These are clearly only a few of the possible cases which can be uncovered and analyzed using the framework proposed here.

In what follows, the data requirements of the model will first be discussed. Then a sequence of illustrative applications will be given designed to show the range of model analyses possible.

Data Requirements

In order for the framework to be applicable all the data necessary for the Stefflre analysis is required. That is, the firm must have invested a substantial amount of money into the research and derivation of the dimensions making up the product space, and customer and brand locations in that space. Incidentally, it might be pointed out that a good validation check on the dimensioning of the space and the locations derived consists of simply predicting market shares from the given positions, and compare with actual shares. If deviations occur, corrections in, for example, the weights in the distance formula (2) might be warranted or a reconsideration of the dimensions chosen could be necessary.

In addition, our firm needs to specify the cost structure involved at alternative locations, as well as its relocation costs should such moves be necessary after an initial positioning. These figures should

be available quite easily from internal records, assuming the firm has been producing and marketing similar products in the past. If not, estimates would have to be arrived at through a study of competitors' situation and general trade data.

As for competitive data, we are basically interested in what reactions will come forth following our alternative brand positionings. If firm predictions can be made on the basis of past experience, management intuition, or other available information, the procedure to follow is clearly to impose these predictions directly upon the product space, and then reiterate the analysis for our brand. Most of the time such a straightforward approach is not feasible, and instead more indirect information has to be utilized. We would then need data on competitors' cost situation, including moving costs, some of which would undoubtedly have to be inferred on the basis of rather scanty information. On the other hand, in the case where our firm has produced and marketed similar products in the past, its own cost structure should be of some guidance.

Furthermore, an assessment of the objective--and thus the propensity to react--of each competitor will have to be made. Here guidance will be given by past competitive actions as well as published information about the competitors generally. A great deal of management judgment seems necessary in the final analysis, however, taking into account present and expected future conditions in the market, which would affect the objectives of a competitor at the time of entry.

In the model, varying customer potentials and dimension weights are incorporated. Such data would usually be estimates on the basis of market research. In the case of industrial products, where each customer might be of considerable importance, the data are fairly easy to

get. As for consumer goods--the case dealt with in the usual Stefflre analysis--each customer location would generally be seen as the centroid of a homogeneous market segment, in which case the potential would represent the total unit sales to that segment, data which are also reasonably easy to obtain. The dimension weights would here have to be the average weights of the particular segment at hand.

Some Illustrative Applications

In the following sections, some examplifying applications of the model framework in a given market structure will be given. A few simplifying assumptions implicit in the preceding model development will be maintained throughout. These state that (1) the total market is not increased by the new entry, (2) the case of loyalties and other factors making a customer stay with a brand further away than another have all been reflected in the price weight, but that (3) in the case of a tie in the weighted distances the existing brand will keep the customer. These assumptions can be relaxed without much difficulty, but the main features of the analysis can be exhibited more clearly without the added complexity.

The model was used to evaluate alternative product positionings in a 2-dimensional product space with two existing competitors and 15 ideal points.[2] The parameters used for the runs are depicted in Table 1.

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[2] The initial positioning of the existing brands was chosen so as to correspond to a certain real world situation found in many cases. It placed one brand (the "old" brand, here labelled competitor one) close to a fairly big customer/segment, but not at the core of the market. The other brand (the "dynamic" one, competitor two) was placed squarely in the middle of a set of customers/segments, not very close to the old brand. The approach of using starting points equal to the competitive niche or joint profit maximizing solutions was avoided because the equilibrium state they imply is so rarely found in the real world.

The unit variable costs for the positioning firm were allowed to differ between alternative locations, depending linearly upon the distance from a "minimum cost" point located at the origin. Thus, when an alternative location was considered, unit variable costs were computed as the intercept plus a slope coefficient times the absolute distance the origin (see Table 1).

In the runs presented here, the fixed costs were set as constant over the whole product space. Both variable and fixed costs differed between the firms, but in this particular application all the firms were assigned the same moving costs. Price for the positioning firm was computed as a markup on unit variable costs, so as to allow for different prices at different locations. The markup was set at 40% for all the runs. An exception to this pricing practice was made for the runs where the objective was joint profit maximizing, since that objective was maximized where costs--and consequently price--was especially high, leading to extreme positionings. In these cases the price for the positioning firm was set at competitive parity, computed as the average price of the competing brands. These choices of parameter settings could be immediately adapted to the particular case at hand without any complications of the model's subsequent application. The settings here were chosen so as not to complicate the applications unnecessarily. For the same reason, the customer weights of the separate dimensions, w_{j1}, were set equal to 1.0 for all the customers.

The Case of No Competitive Response

Using the proposed framework to its full advantage requires an analysis of what competitors might do if we introduce our brand at some particular location. There are several situations that could occur.

First, it might be reasonable to assume that competitors will react very reluctantly--their management is conservative, for example--or if they decide to react, they can only do so after a long delay. The first case will sometimes occur in markets where the existing brands are old and well established and no new introduction has been made recently. The second case would often obtain in markets where positioning is based upon long term image development and a change in image is difficult and timeconsuming--automobiles is a case in point.

Under the assumption of a lack of reaction, the positioning case becomes equivalent to the Stefflre approach. The best choice would simply be given by the model once the objective is specified--and the optimal location would be found subject to the fixed positions of the existing brands.

In such a case, a firm might enjoy some considerable benefits from a profit maximizing location. This is clearly examplified in Figure 1, which depicts the results from the initial runs. As can be seen, the profit-maximizing position--at location 3/2--yields profits about double those of the competitors. This occurs only because of the switching of customers from the second competitor, however, who lost seven of his ten customers, and would most likely react in some way.

The sales maximizing objective would argue for a similar positioning in this case with consequently identical results. The competitive niche solution places our brand as expected in a rather untapped segment of the space--at location 4/-2--but even these customers represent considerable lost sales to the competitors. The sales are now more evenly divided, however, as compared to the profit maximizing case.

Finally, in the joint profit maximizing case the optimal location is at -2/-1 placing the new brand squarely in between the two existing brands. As in the case of the niche solution the joint objective is less aggressive than the profit maximizing alternative, but some loss of sales will by necessity occur, this time mainly from the first competitor. If the losses take place as indicated by the weighted distance formula, one would think that competitor one would have to react in some fashion to the new entry.[3]

The Case of a Competitive Re-positioning

From the first set of runs of the model we can establish three alternative optimal entry positions depending upon the objective function chosen. It is clear that if the management judgment in our firm is that no moves will be undertaken by the existing brands, the 3/2 location is the best. On the other hand a safer strategy might be to opt for the niche solution, under the assumption that none of the competitors will accept the potential losses of our other two positionings without reacting. In such a case our new entry might do better in the long run by a less aggressive positioning.

Thus, the next step in the analysis clearly consists of analyzing the possible moves a competitor might make in response to our entry. One alternative would be to postulate that there could be a reaction after some delay, but that after such an adjustment everybody would "settle down." This could be the case where reaction is possible

[3] It should perhaps be noted that in the last two cases customer satisfaction is likely to be greater than in the profit maximizing case, since the number of well differentiated product alternatives is greater. This is a case, then, where a profit maximizing approach is not tantamount to maximal customer satisfaction.

within a reasonable period of time--and competitors are willing to move--but any further movements are infeasible because of prohibitive costs and/or negative customer reactions. Many cosmetics products would provide cases in point. The tradeoff between two alternative positionings would then clearly depend upon the length of the planning horizon relative to the length of the reaction period. If the latter is brief relative to the former, the payoff after reaction will matter most, and vice versa. The model presented here gives us the ability to evaluate--for alternative competitive objective functions--what their likely reactions will be.

The results of such an analysis are presented in Figure 2. The figure depicts the various locations that competitor two would choose given our entry position and a particular objective function. Thus, the challenging profit maximizing entry by our firm at location 3/2 leads to a simple relocation by a profit-maximizing competitor two, just shifting down one step to recover the lost "core" segment and still maintain his hold over most of the old customers. This simple readjustment is an illustration of the location problem commonly known as the "beach icecream salesman" case, where a positioning close to a competitor will take away all customers to one side, but will also make a quick "move one over" reaction possible.

It is also interesting to see that with our challenging entry, if competitor two wants to yield by developing a new niche for himself rather than a simple counterchallenge he will move down to our first niche position at 4/-2. Although this would sometimes seem a less likely outcome in any real world setting, it might well describe Detroit's initial reaction to some of the subcompact imported cars.

In the case the reacting competitor two operates under a joint profit maximizing objective--perhaps in a sense accepting the fact that now there will be three brands to share the total market--the optimal location will be at 1/0, that is in-between the new entrant and the existing brand 1. As in the case of the niche solution the profits will be more evenly divided among the three brands, and even with the relatively small move involved a much better "fit" to consumer desires is obtained.

In Figure 3 are depicted the reactions on the part of competitor 1 to our entry at the profit maximizing position 3/2. They all incorporate considerable moves from the present position. When it is realized that our introduction only attracts one customer from competitor 1 the model predictions should be treated with some care, however. In fact, the existing location of competitor 1 is suboptimal--even without a new entry--using any one of the four objective functions. When this turns out to be the case, one would assume that the predicted moves will not materialize, unless the losses suffered were quite high. In the present case it seems safe o assume that competitor 1 will not move (one possible alternative objective that might correctly characterize competitor one's present position would be a desire for "stability").

Turning to our competitive niche positioning, again our sales will draw mostly from competitor two, competitor one not being touched anymore than in the profit maximizing case. This can be seen clearly in Figures 4 and 5. For the second competitor the profit maximizing location involves hardly any move at all, an indication of the advantage of our less aggressive entry positioning. The sales maximization option,

however, still leads to a challenging move very close to our entry position. Since the competitor under this objective basically ignores the costs, such a move would generally be quite reckless. On the other hand, under the assumption that the new entrant can be successfully "attacked" before he gains a foothold, such an approach again might be profitable in the long run.

The competitive niche and joint profit maximization options lead to quite similar positionings, much closer to the core of the market than the profit maximizing position. The reasons for the somewhat surprising move closer to the center seems to be the lower costs involved in operating there (which affects the joint profit solution) and the relatively low price the second competitor can then charge for its products (which affects the niche solution). Thus, should the minimum cost point be located closer to competitor 2's present location, one would conjecture that these two solutions would lie even closer to the initial position.[4]

Since the first competitor finds himself in the same situation under our niche entry as under the previous profit maximizing entry, the prediction of his actions can be carried out exactly as there.[5]

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[4]It should be noted that this type of conjecture constitutes one of the fruitful points for consideration brought out by the use of the present model. These points and other similar questions can be analyzed with the help of the usual type of sensitivity analysis. In any real-world application such sensitivity analysis becomes mandatory.

[5]In the case where only one competitor is likely to react, a game theory approach might possibly yield a saddle point solution. In general, however, the game is not zero-sum, since it is always possible to draw extra sales from the non-reacting competitor(s).

In Figures 6 and 7 the possible competitive responses to our entry at -2/-1--the joint profit maximizing position--are shown. This time competitor one will lose several of his customers by our entry--three out of five to be exact--and as a result the model predicts some substantial moves, except for the joint profit maximizing case. Both the profit maximizing and sales maximizing strategies would lead him to challenge competitor two, a positioning that seems quite unlikely considering his earlier reluctance to do that. Even so, with a new brand in the market the best move is clearly to attack not the new brand--remember that the entering brand is here joint profit maximizing, a non-aggressive option--but rather the other established brand. If competitor one would rather "switch than fight" it is clear that the niche solution positioning the brand at 4/-2 will provide a quite acceptable alternative, since there the profits will not be much worse than in the initial location with only one competitor.

For our jointly maximizing entry, competitor two will have relatively little need for re-positioning. True, his sales maximizing approach would still lead to a challenge at 0/-2, but basically the other three objectives lead to some small movement towards the core of the market, to recapture some marginal customers and to take advantage of the lower operating costs in the center. The joint profit maximizing location clearly will hurt competitor one much more than competitor two.

Summarizing the results from this discussion of the "first order" reactions by the existing brands, it seems clear that short run profit maximizing entry at 3/2 will invite retaliation by competitor two, leaving us rather badly off afterwards. The joint profit maximizing

entry at -2/-1, on the other hand, potentially affects competitor one's sales considerably, making retaliatory repositioning of his brand a strong possibility, and probably forcing a subsequent move by competitor two. Our safest bet seems to be the competitive niche position at 4/-2 which minimizes the risk for competitive repositioning and still leaves us with a quite reasonable profit.

The Case of Several Competitive Relocations

It might be that further reactions are possible, however, so that after the competitors' initial reaction, our firm has the possibility of repositioning to another spot, and that even further moves are feasible. This could be the case where strictly functional and easily changed characteristics of the products matter, so that by changing the product specifications to a limited extent, new customers could be attracted. A case in point might be industrial markets for chemical products or a consumer durables market such as a stereo component set. In these situations, the appropriate application of the model presented involves several relocations before either a limit on the number of moves is encountered, or an equilibrium position of the brands is arrived at. In general, these potential moves would need to be carried out for a number of alternative starting points, so that the one with the highest total expected value could be picked by the entering firm.

We will extend the preceding one stage illustration to exhibit some of the characteristics of the multi-stage location problem. In Figure 8 a possible sequence of relocations by competitor two and the new brand entering at 3/2 is displayed. As we saw in the earlier discussion, the first competitor is not affected directly by this entry. The

second competitor on the other hand does suffer considerably. As a consequence, he might move to position 2/2, his profit maximizing position after our entry. Given such a response, we might want to persist in which case our profit maximizing move is to 1/1, that is, just one move over. Given that both firms persist in this aggressive behavior there will not be an equilibrium, but the "one-move-over" pattern will persist throughout. This case of cutthroat competition does occur especially in local markets--but see also the rent-a-car business for a national example--and as a new entrant we might want to avoid such a potentially costly positioning strategy.

Accordingly, the new entrant might develop a strategy of initially entering at his short run maximizing position 3/2 and then "retire" to the niche solution as soon as competitor two reacts. In this way some possibility is retained of getting the most of competitor two's customers (in case two does not react), while at the same time a costly competitive warfare is avoided. The likely outcome is portrayed in Figure 9, where it is assumed that competitor two will yield to a niche solution (at 1/1) once we settled at our niche position (4/-2). The profits at this location can then be compared with the profits obtained throughout the incessant warfare, and with the payoffs for an initial direct location at 4/-2, and the strategy with the highest (expected) value chosen.

If the assumption of a quickly yielding competitor is seen as unrealistic it is easy enough to see what would happen if he persists in using the profit maximizing objective. In Figure 10 is depicted the probable sequence of events; he will (as could be expected) largely pursue us to the alternative niche locations we move to (conditional

upon his last move), and again no particular positions will be stable. On the other hand, it is interesting to note that in this particular example the two firms will end up shifting between the two positions 1/1 and 4/-2, and one would expect that in such a market structure some accommodation would sooner or later be reached between the firms--provided, of course, that the financial capabilities of the entering firm will allow a struggle at all.

Where the entering firm wants to avoid reprisals if at all possible, then, the initial niche choice seems again the best choice in the given market structure. The firm might still ask itself whether it might not improve its profit position, however, by choosing some similar alternative location; the niche solution, after all, is determined with reference to the minimum customer distance, which really does not reflect completely the profit picture of the firm. One procedure to follow could then be to isolate all the points in the product space where the competitive effects are identical to the niche solution--so that the probability of competitive reaction is the same--but where profits are higher. One such location is at 3/-4, somewhat "below" the niche solution (see Figure 1). By locating even further away from the core of the market and from the competitors, the entering firm will still attract its earlier customers but can charge a higher price. That such an opportunity can exist in practice is clear from many sellers of high priced consumer goods focusing upon an "exclusive" segment of the market.

Also, the entering firm might simply want to consider some points yielding some more sales than the niche solution, but yet not aggressive enough to directly affront some particular competitor. In such a case it might be interesting to consider the two alternatives 3/-1 and 3/0

which both yield higher sales and profit than locating at 4/-2. For the 3/0 location the model predicts a countermove to 2/0 by a profit-maximizing second competitor, and as before, the war fare is on (see Figure 11). A weak competitor two will basically not move, and will still maintain some sales at his old location, although more than half of the customers go to the new entry. Accordingly, one would generally expect a more aggressive reaction.

For the 3/-1 option, however, the profitmaximizing competitor two will only move to 2/2, a reasonably conservative countermove. In fact, the niche response is greater, (to 1/1) due to the higher price the model allows for the 2/2 position. The move to 2/2, however, is sufficient to recover the lost core of the market. Comparing the profit made at an entry location of 4/-2 versus one at 3/-1 with a competitive move to 2/2, we see that the position at 4/-2 involving greater product differentiation will be slightly preferable in the long run.

In sum, when several sequential reactions are possible, a number of alternative patterns might emerge. Basically, if two firms engage in profitmaximizing behavior with respect to all the segments, the model predicts cutthroat competition, until one competitor yields some segment(s) to the other or is forced out of the market. Even where only one firm engages in aggressive "bullying" of the other firms, an equilibrium position might not be found unless the yielding firms give up most of their customers. It is in such cases that the number of necessary feasible sequential moves be predetermined for the analysis to have a terminal point.

Where the reactions of the firms take considerable time, the short run gains of the entrant will be significant in the profit picture.

Furthermore, subsequent moves will also be of interest since the new transient positions will be held for quite some time.[6] Finally, in the case where reactions are quick, so that the equilibrium or terminal positions are reached quite early, the analysis can be focused upon the gains at the final positions, and an evaluation of the alternative starting points concentrated upon these values.

Possible Extensions

There are several extensions of the presented model framework that can be proposed. For example, the competitive reaction is treated as an either-or phenomenon, with the focus upon where the competitor would move if at all. Clearly, in most cases the reaction is better seen as probabilistic, with a certain chance of a response conditional upon a given entry location. Then the model would be used for the prediction of the chosen position by the competitor, given that a reaction occurs.

Such a probabilistic approach necessitates the assignment of likelihoods of reaction for each competitor separately, given alternative entry points and consequent sales losses. This assignment has to be done on the basis of management judgment with support of whatever data are available. Then, for each trial location, the customer purchases are computed by the model, and used in conjunction with the assigned probabilities to develop the likelihoods of competitive response. The payoffs to the entering firm for that particular trial location are

[6] In many cases it might be most realistic to see the re-locations as an ongoing market phenomenon, the equilibrium or terminal points never reached because of external shocks to the market, changing the very positions of these points. In such dynamic markets the re-positioning might take place not necessarily in sequence but rather more or less simultaneously. Such markets will clearly need more sophisticated analysis than we can carry out here.

then computed as the weighted average of the profits from the no-response case and the profits from the response case, the likelihoods constituting the weights. These payoffs would be computed in the same way as the payoffs in the earlier cases discussed.

Another extension would allow for the probable imprecision in the firm's ability to position a brand within the given product space. As was indicated in the beginning, it is assumed throughtout that exact positioning is possible. If this is not the case, so that only approximate locations can be determined, the trial locations evaluated by the model clearly need to be fewer. This can quite easily be dealt with by letting the algorithm make bigger jumps, for example. A related problem, that of not being able to locate next to a competitor, can also be accommodated easily within the model by eliminating trial locations within some radius of the competitors.

If it is desired that the loyalty to established brands be allowed to differ between customers, separate weighting factors (in addition to price) can easily be assigned to the different customers. Similarly, the possibility of splitting the sales between two equidistant competitors can be directly incorporated.

Another possible extension would be to allow customers and competitors to change positions over time without any necessary overt actions. This would correctly describe at least the experience of new customers and new firms attempting to build up a market niche. In the latter case, the model could quite easily be extended to incorporate a trial period for the entering brand, so that switching from the old brands would be probabilistic, perhaps increasing with decreasing distance and with the number of already converted customers. There would be some

problem in assessing these probabilities, but the approach seems feasible (panel data might be useful).

Changing desires on the part of the customers--and consequent changes in their locations--will, however, create problems. If the changes can be predicted, the evaluation will simply consist of a sum of payoffs over the planning period using the forecasted location changes. If these predictions are probabilistic, the sum of the payoffs will consist of a sum of random variables, and an expected payoff maximization approach will have to be followed. Both those cases can be dealt with quite easily with some algorithm changes. The problem is that customer changes will in many cases be very difficult to predict, and their magniture and timing hard to spot in advance. Given this, one might want to simply see them as random shocks internal to the model, and work with the present values established by the research, using the model in exactly the way presented above, accepting the inevitable loss of predictive accuracy.

Summary

In this paper, a decision model for new product positioning in the face of potential competitive response has been developed. Drawing upon earlier work on competitors' and customers' locations in a product space, an iterative clustering algorithm was developed to predict where a reacting competitor might move in case the entering firm attracts several of the competitor's present customers. The model was used for the evaluation of best entry position for an illustrative case with alternative objective functions for the entrant as well as for the existing firms.

As with many other models, the value of the proposed framework to marketing management probably lies less in the explicit solution of the product positioning problem--although such a solution are directly derived for any particular specification--than in the sharp relief into which the model sets the crucial issues of new product positioning. As such, the model should be of use not only to management, but also to public policy makers with an interest in developing conditions favorable to a customer oriented differentiation of product offerings.

TABLE 1

Parameter Settings

# of Customers/Segments = 15
# of Competitors/Existing Brands = 2
# of Dimensions = 2

Competitor 1	Location = -4.00 -4.00	
Fixed Costs = 10.00	Var. Costs = 8.00	Price = 12.00
Moving Costs = 1.00 2.00	Revenue = 120.00	Profits = 30.00
Competitor 2	Location = 2.00 3.00	
Fixed Costs = 12.00	Var. Costs = 7.00	Price = 12.00
Moving Costs = 1.00 2.00	Revenues = 300.00	Profits = 113.00

Customer = 1	Location = 1.00 1.00	Potential = 2.00
Customer = 2	Location = 2.00 1.00	Potential = 3.00
Customer = 3	Location = -1.00 5.00	Potential = 1.00
Customer = 4	Location = -5.00-1.00	Potential = 3.00
Customer = 5	Location = -5.00 0.00	Potential = 1.00
Customer = 6	Location = 3.00-4.00	Potential = 2.00
Customer = 7	Location = 5.00 3.00	Potential = 2.00
Customer = 8	Location = 1.00 0.00	Potential = 2.00
Customer = 9	Location = 5.00-4.00	Potential = 4.00
Customer = 10	Location = 2.00 4.00	Potential = 3.00
Customer = 11	Location = -4.00-5.00	Potential = 3.00
Customer = 12	Location = -2.00-1.00	Potential = 1.00
Customer = 13	Location = 3.00-1.00	Potential = 2.00
Customer = 14	Location = 4.00-2.00	Potential = 2.00
Customer = 15	Location = 3.00 4.00	Potential = 4.00

Data on Positioning Firm

Fixed Costs = 10.50	Min. Cost Point = 0.00 0.00
Moving Costs = 1.00 2.00	Price as a Prop. of Var. Cost = 4.40
Var. Cost Intercept = 7.00	Var. Cost Slope = 0.10

Objective Function	Code
Own profit max.	1
Joint profit max.	2
Competitive niche	3
Own sales max.	4

FIGURE 1

Initial Entry

Positioning Firm ID. 0
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points market ⊛
(the numbers indicate customer ID#)

Optimal location marked Δ
(the numbers indicate positioning firm ID and objective function ID, respectively).

Objective Function	Code
Own profit max.	1
Joint profit max.	2
Competitive niche	3
Own sales max	4

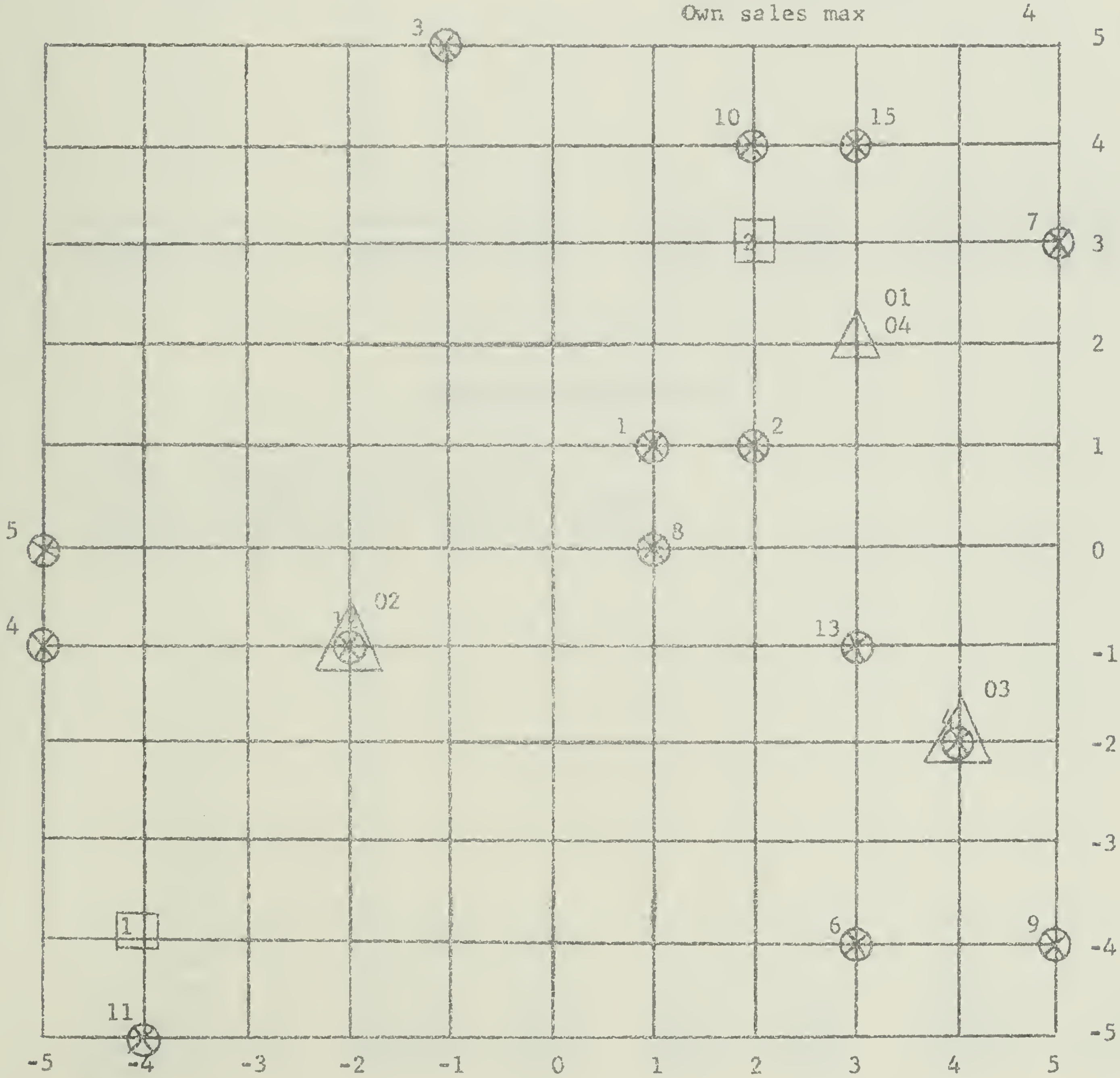

FIGURE 1 (cont'd)
(Positioned Firm Coded as: 3)

Objective Function: 1

Optimal Location = 3.00 2.00
Value of the Objective Function = 52.58
Unit Var. Costs = 8.30 Price = 11.62

Customer #	to Firm #
1	3
2	3
3	2
4	1
5	1
6	3
7	3
8	3
9	3
10	2
11	1
12	1
13	3
14	3
15	2

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 220.78	Costs = 168.20	Profits = 52.58

Objective Function: 2

Optimal Location = -2.00 -1.00
Value of the Objective Function = 134.50
Unit Var. Costs = 7.50 Price = 12.00

Customer #	to Firm #
1	2
2	2
3	2
4	3
5	3
6	3
7	2
8	2
9	2
10	2
11	1
12	3
13	2
14	2
15	2

Competitor = 1	Revenue = 36.00	Costs = 34.00	Profits = 2.00
Competitor = 2	Revenue = 300.00	Costs = 187.00	Profits = 113.00
Competitor = 3	Revenue = 84.00	Costs = 64.50	Profits = 19.50

FIGURE 1 (cont'd)

Objective Function: 3

Optimal Location = 4.00 -2.00
Value of the Objective Function = 413.88
Unit Var. Costs = 9.00   Price = 12.60

Customer #	to Firm #
1	2
1	2
3	2
4	1
5	1
6	3
7	2
8	2
9	3
10	2
11	1
12	1
13	3
14	3
15	2

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 2	Revenue = 204.00	Costs = 131.00	Profits = 73.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50

Objective Function : 4

Optimal Location = 3.00 2.00
Value of the Objective Function = 220.78

Customer #	to Firm #
1	3
2	3
3	2
4	1
5	1
6	3
7	3
8	3
9	3
10	2
11	1
12	1
13	3
14	3
15	2

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 220.78	Costs = 168.20	Profits = 52.58

FIGURE 2

Competitor Two's Reaction to a Profit Max. Entry

Positioning Firm ID: 2
("0" for new entry)

Existing brands' location marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked △

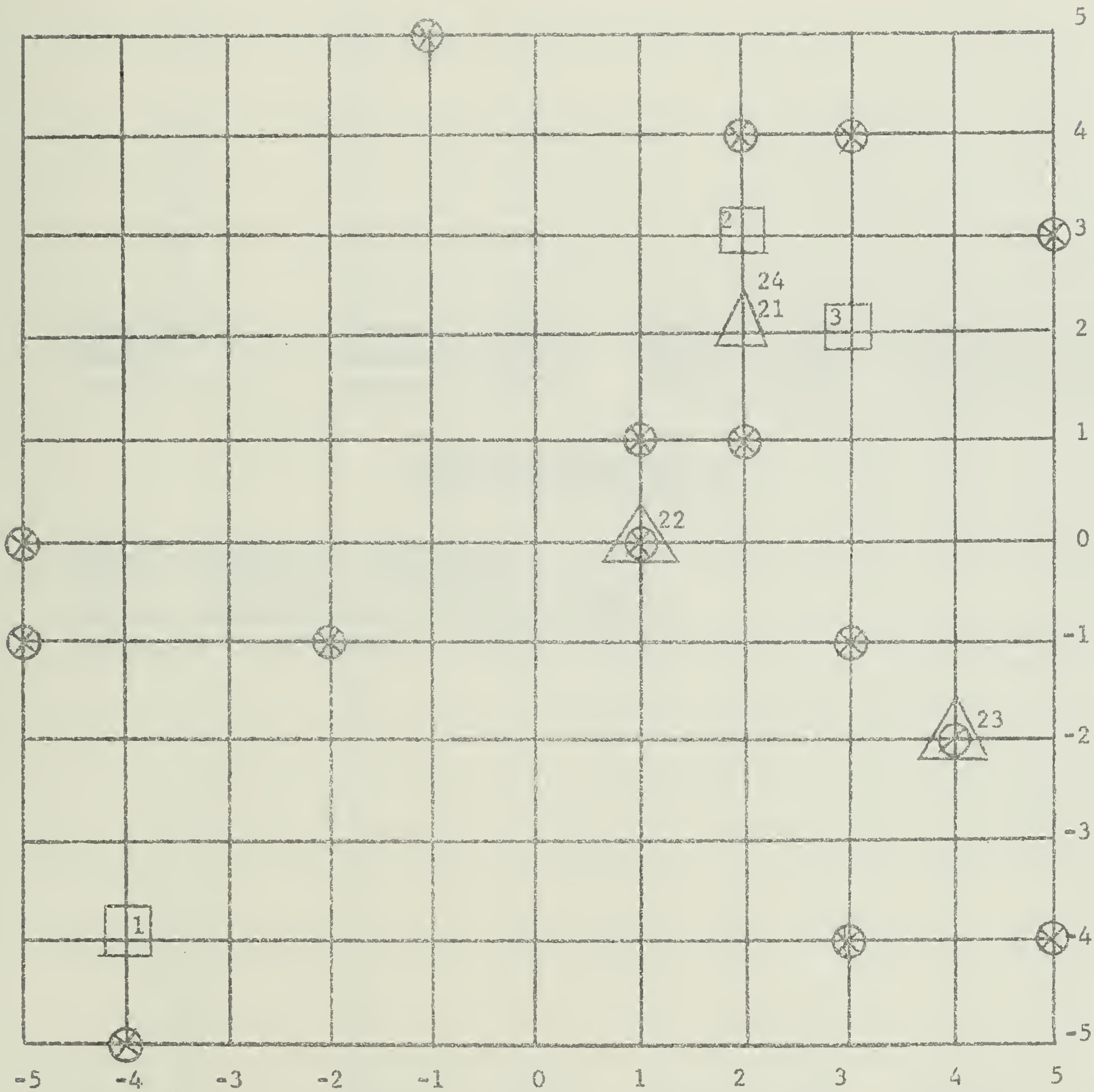

FIGURE 2 (cont'd)
(Positioned Firm Coded as: 4)

Objective Function: 1

Optimal Location = 2.00 2.00
Value of the Objective Function = 45.28
Unit Var. Costs = 7.80 Price = 10.92

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	4
7	3
8	4
9	4
10	4
11	1
12	1
13	4
14	3
15	3

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 93.60	Costs = 76.90	Profits = 16.70
Competitor = 4	Revenue = 207.48	Costs = 160.20	Profits - 47.28

Objective Function: 2

Optinal Location = 1.00 0.00
Value of the Objective Function = 104.70
Unit Var. Costs = 7.10 Price = 11.90

Customer #	to Firm #
1	4
2	3
3	3
4	1
5	1
6	4
7	3
8	4
9	4
10	3
11	1
12	4
13	4
14	4
15	3

Competitor = 1	Revenue = 84.00	Costs = 66.00	Profits = 18.00
Competitor = 3	Revenue = 152.10	Costs = 118.40	Profits = 33.70
Competitor = 4	Revenue = 178.50	Costs = 118.50	Profits = 60.00

FIGURE 2 (cont'd)

Objective Function: 3

Optimal Location = 4.00 -2.00
Value of the Objective Function = 426.88
Unit Var. Costs = 9.00 Price = 12.60

Customer #	to Firm #
1	3
2	3
3	3
4	1
5	1
7	4
7	3
8	3
9	4
10	3
11	1
12	1
13	4
14	4
15	3

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 198.90	Costs = 151.60	Profits = 47.30
Competitor = 4	Revenue = 126.00	Costs = 102.00	Profits = 24.00

Objective Function: 4

Optimal Location = 2.00 2.00
Value of the Objective Function = 207.48
Unit Var. Costs = 7.80 Price = 10.92

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	4
7	3
8	4
9	4
10	4
11	1
12	1
13	4
14	3
15	3

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 93.60	Costs = 76.90	Profits = 16.70
Competitor = 4	Revenue = 207.48	Costs = 160.20	Profits = 47.28

FIGURE 3

Competitor One's Reaction to a Profit Max. Entry

Positioning Firm ID: 1
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked Δ

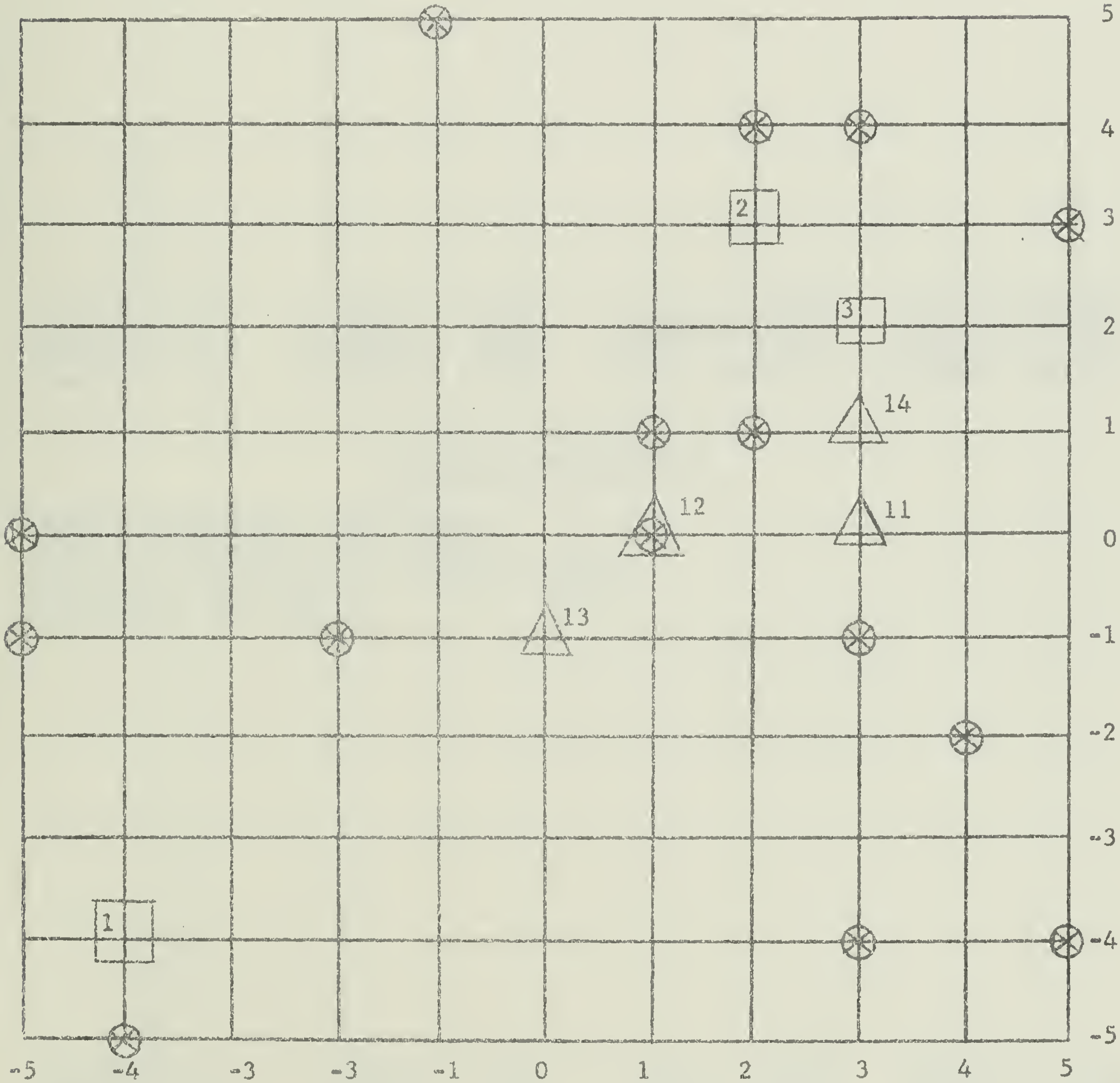

FIGURE 3 (cont'd)
(Positioned Firm Coded as: 4)

Objective Function: 1

Optimal Location = 3.00 0.00
Value of the Objective Function = 54.00
Unit. Var. Costs = 7.90 Price = 11.06

Customer #	to Firm #
1	4
2	4
3	2
4	4
5	4
6	4
7	3
8	4
9	4
10	2
11	4
12	4
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 23.40	Costs = 27.10	Profits = -3.70
Competitor = 4	Revenue = 276.50	Costs = 207.50	Profits = 69.00

Objective Function: 2

Optimal Location = 1.00 0.00
Value of the Objective Function = 117.10
Unit Var. Costs = 7.10 Price = 11.90

Customer #	to Firm #
1	4
2	3
3	2
4	4
5	4
6	4
7	3
8	4
9	4
10	2
11	4
12	4
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 58.50	Costs = 52.00	Profits = 6.50
Competitor = 4	Revenue = 261.80	Costs = 166.20	Profits = 95.60

FIGURE 3 (cont'd)

Objective Function: 3

Optimal Location = 0.00 -1.00
Value of the Objecfive Function = 498.66
Unit Var. Costs = 7.10 Price = 9.94

Customer #	to Firm #
1	4
2	3
3	2
4	4
5	4
6	4
7	3
8	4
9	4
10	2
11	4
12	4
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 58.50	Costs = 52.00	Profits = 6.50
Competitor = 4	Revenue = 218.68	Costs = 116.20	Profits = 52.48

Objective Function: 4

Optimal Location = 3.00 1.00
Value of the Objective Function = 280.00
Unit Var. Costs = 8.00 Price = 11.20

Customer #	to Firm #
1	4
2	4
3	2
4	4
5	4
6	4
7	3
8	4
9	4
10	2
11	4
12	4
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 23.40	Costs = 27.10	Profits = -3.70
Competitor = 4	Revenue = 280.00	Costs = 210.00	Profits = 70.00

FIGURE 4

Competitor Two's Reaction to a Competitive Niche Entry

Positioning Firm ID: 2
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked Δ

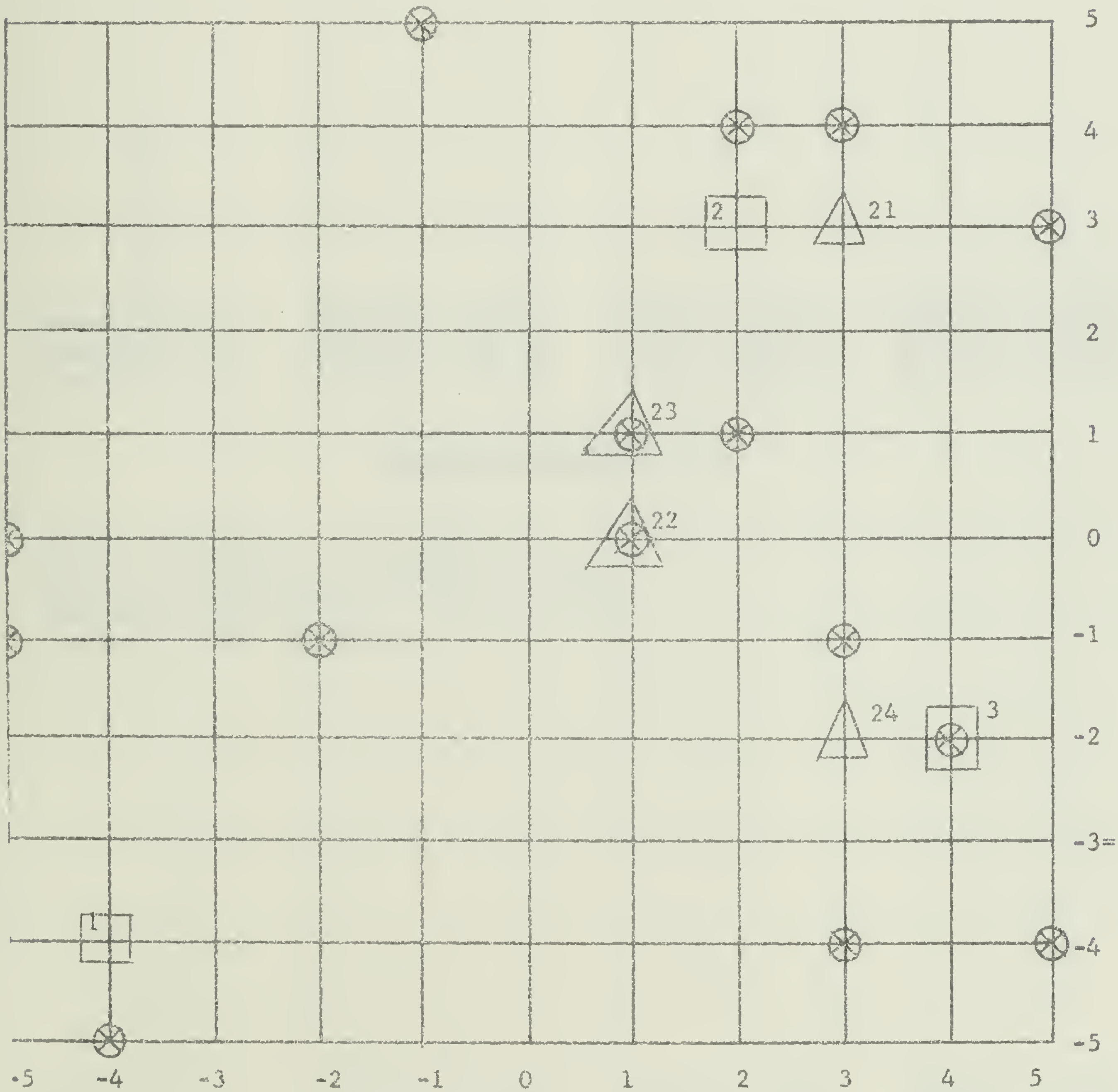

FIGURE 4 (cont'd)
(Positioned form coded as: 4)

Objective Function: 1

Optimal Location = 3.00 3.00
Value of the Objective Function = 46.84
Unit. Var. Costs = 8.80 Price = 12.32

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	3
7	4
8	4
9	3
10	4
11	1
12	1
13	3
14	3
15	4

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 209.44	Costs = 161.60	Profits = 47.84

Objective Function: 2

Optimal Location = 1.00 0.00
Value of the Objective Function = 116.30
Unit Var. Costs = 7.100 Price = 12.20

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	3
7	4
8	4
9	3
10	4
11	1
12	4
13	3
14	3
15	4

Competitor = 1	Revenue = 84.00	Costs = 66.00	Profits = 18.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 219.60	Costs = 139.80	Profits = 79.80

FIGURE 4 (cont'd)

Objective Function: 3

Optimal Location = 1.00 1.00
Value of the Objective Function = 388.47
Unit Var. Costs = 7.20 Price = 10.08

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	3
7	4
8	4
9	3
10	4
11	1
12	4
13	3
14	3
15	4

Competitor = 1	Revenue = 84.00	Costs = 66.00	Profits = 18.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 181.44	Costs = 141.60	Profits = 39.84

Objective Function: 4

Optimal Location = 3.00 -2.00
Value of the Objective Function = 244.02
Unit Var. Costs = 8.30 Price = 11.62

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	4
7	4
8	4
9	3
10	4
11	1
12	1
13	4
14	3
15	4

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 75.60	Costs = 64.50	Profits = 11.10
Competitor = 4	Revenue = 244.02	Costs = 186.30	Profits = 57.72

FIGURE 5

Competitor One's Reaction to a Competitive Niche Entry

Positioning Firm ID: 1
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked △

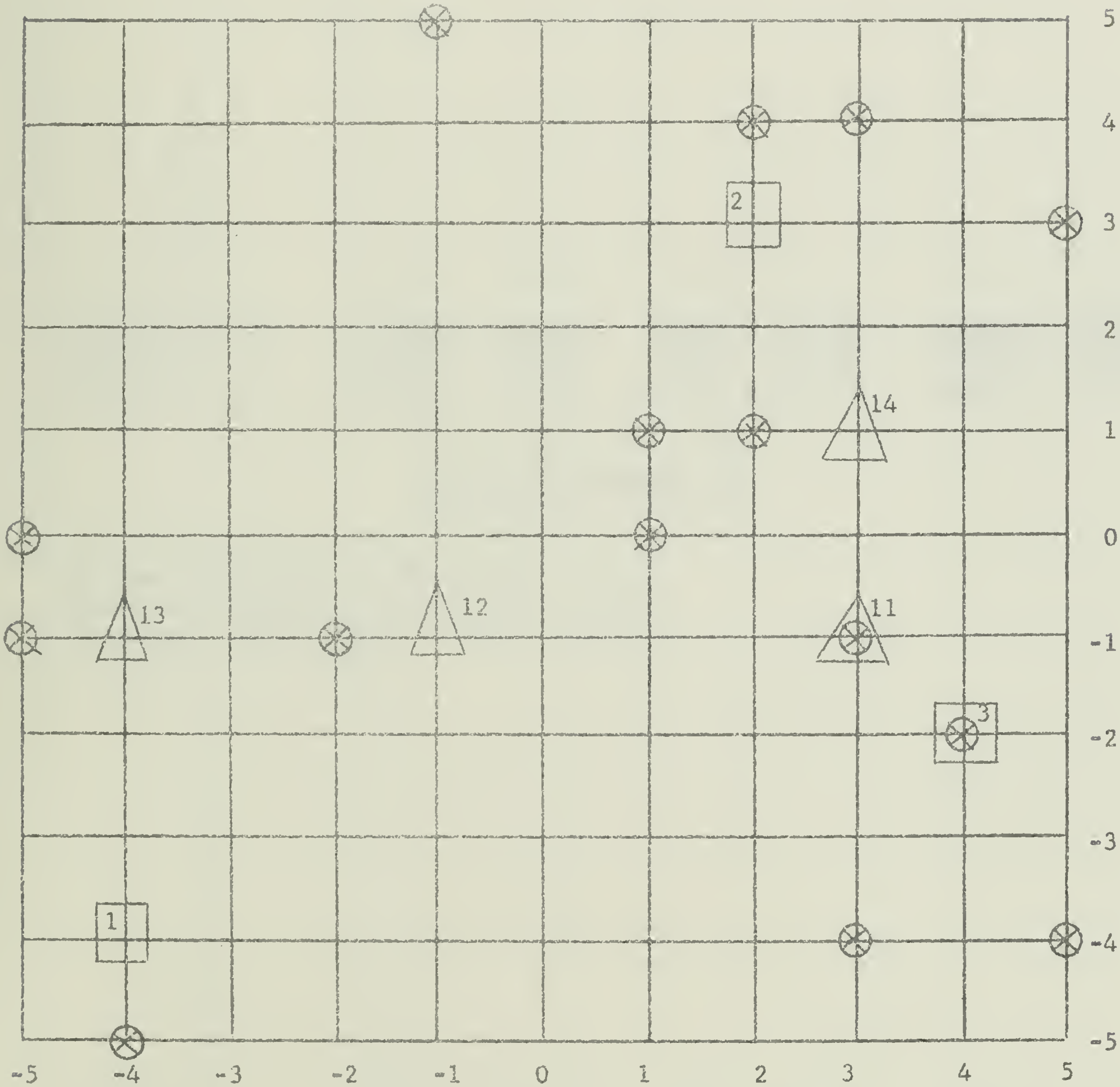

FIGURE 5 (cont'd)
(Positioned Firm Coded as: 4)

Objective Function: 1

Optimal Location = 2.00 -1.00
Value of the Objective Function = 29.00
Unit Var. Costs = 7.50 Price = 10.50

Customer #	to Firm #
1	4
2	4
3	2
4	4
5	4
6	3
7	2
8	4
9	3
10	2
11	4
12	4
13	4
14	3
15	2

Competitor = 2	Revenue = 120.00	Costs = 82.00	Profits = 38.00
Competitor = 3	Revenue = 100.80	Costs = 82.50	Profits = 18.30
Competitor = 4	Revenue = 178.50	Costs = 137.50	Profits = 41.00

Objective Function: 2

Optimal Location = 0.00 -1.00
Value of the Objective Function = 119.50
Unit Var. Costs = 71.0 Price = 12.20

Customer #	to Firm #
1	2
2	2
3	2
4	4
5	4
6	3
7	2
8	4
9	3
10	2
11	4
12	4
13	3
14	3
15	2

Competitor = 2	Revenue = 180.00	Costs = 117.00	Profits = 63.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 122.00	Costs = 81.00	Profits = 41.00

FIGURE 5 (cont'd)

Objective Function: 3

Optimal Location = -4.00 -1.00
Value of the Objective Function = 373.67
Unit Var. Costs = 8.70 Price = 12.18

Customer #	to Firm #
1	2
2	2
3	2
4	4
5	4
6	3
7	2
8	2
9	3
10	2
11	4
12	4
13	3
14	3
15	2

Competitor = 2	Revenue = 204.00	Costs = 131.00	Profits = 73.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 97.44	Costs = 79.60	Profits = 17.84

Objective Function: 4

Optimal Location = 3.00 1.00
Value of the Objective Function = 190.40
Unit Var. Costs = 8.00 Price = 11.20

Customer #	to Firm #
1	4
2	4
3	2
4	4
5	4
6	3
7	4
8	4
9	3
10	2
11	4
12	4
13	3
14	3
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 190.40	Costs = 146.00	Profits = 44.40

FIGURE 6

Competitor Two's Reaction to a Joint Profit Max. Entry

Positioning Firm ID: 2
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked △

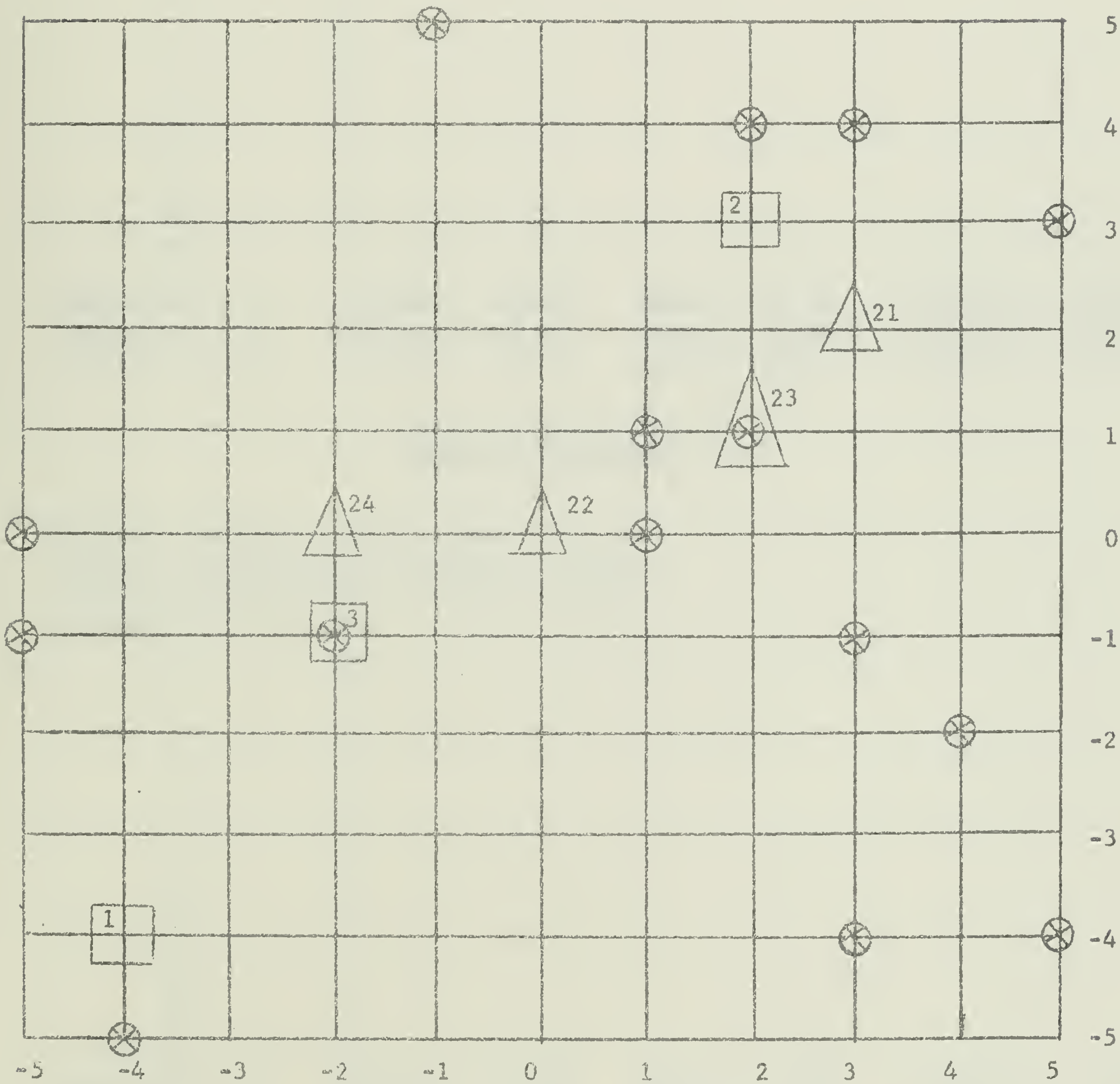

FIGURE 6 (cont'd)
(Positioned Firm Coded as: 4)

Objective Function: 1

Optimal Location = 3.00 2.00
Value of the Objective Function = 74.64
Unit Var. Costs = 8.30 Price = 11.62

Customer #	to Firm #
1	4
2	4
3	4
4	3
5	3
6	4
7	4
8	4
9	4
10	4
11	1
12	3
13	4
14	4
15	4

Competitor = 1	Revenue = 36.00	Costs = 34.00	Profits = 2.00
Competitor = 3	Revenue = 60.00	Costs = 48.00	Profits = 12.00
Competitor = 4	Revenue = 313.74	Costs = 236.10	Profits = 77.64

Objective Function: 2

Optimal Location = 0.00 0.00
Value of the Objective Function = 129.00
Unit Var. Costs = 7.00 Price = 12.00

Customer #	to Firm #
1	4
2	4
3	4
4	3
5	3
6	4
7	4
8	4
9	4
10	4
11	1
12	3
13	4
14	4
15	4

Competitor = 1	Revenue = 36.00	Costs = 34.00	Profits = 2.00
Competitor = 3	Revenue = 60.00	Costs = 48.00	Profits = 12.00
Competitor = 4	Revenue = 324.00	Costs = 201.00	Profits = 123.00

FIGURE 6 (cont'd)

Objective Function: 3

Optimal Location = 2.00 1.00
Value of the Objective Function = 442.46
Unit Var. Costs = 7.50 Price = 10.50

Customers #	to Firm #
1	4
2	4
3	4
4	3
5	3
6	4
7	4
8	4
9	4
10	4
11	1
12	3
13	4
14	4
15	4

Competitor = 1	Revenue = 36.00	Costs = 34.00	Profits = 2.00
Competitor = 3	Revenue = 60.00	Costs = 48.00	Profits = 12.00
Competitor = 4	Revenue = 283.50	Costs = 214.50	Profits = 69.00

Objective Function: 4

Optimal Location = -2.00 0.00
Value of the Objective Function = 321.16
Unit Var. Costs = 74.00 Price = 10.36

Customer #	to Firm #
1	4
2	4
3	4
4	4
5	4
6	4
7	4
8	4
9	4
10	4
11	1
12	3
13	4
14	4
15	4

Competitor = 1	Revenue = 36.00	Costs = 34.00	Profits = 2.00
Competitor = 3	Revenue = 12.00	Costs = 18.00	Profits = -6.00
Competitor = 4	Revenue = 321.16	Costs = 241.40	Profits = 79.76

FIGURE 7

Competitor One's Reaction to a Joint Max. Entry

Positioning Firm ID: 1
("0" for new entry)

Existing brands' locations marked [1], [2], etc.

Customer ideal points marked (x)

Optimal location marked △

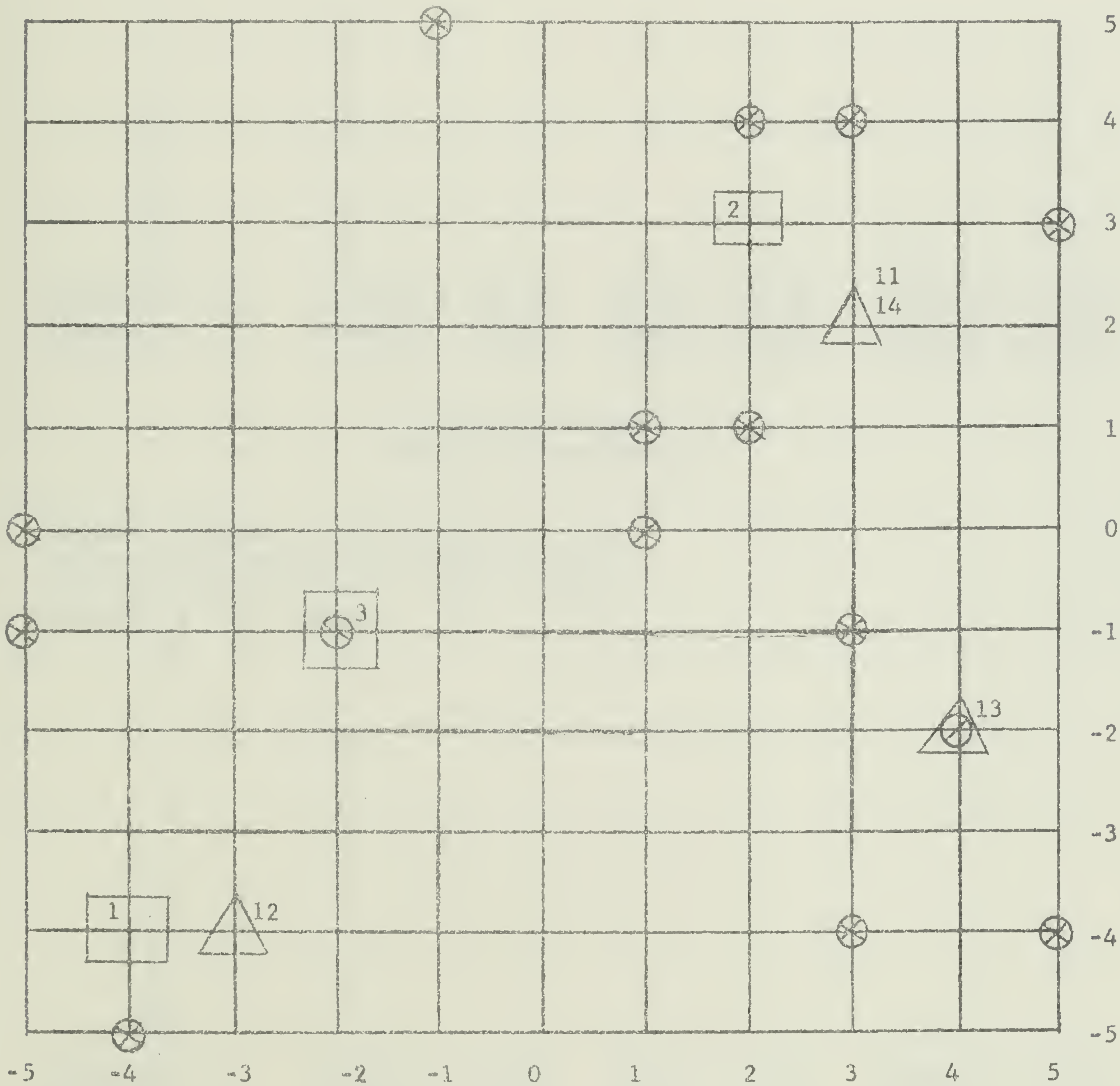

FIGURE 7 (cont'd)
(Positioned Firm Coded as: 4)

Objective Function: 1

Optimal Location = 3.00 2.00
Value of the Objective Function = 34.08
Unit Var. Costs = 8.30 Price = 11.62

Customer #	to Firm #
1	4
2	4
3	2
4	3
5	3
6	4
7	4
8	4
9	4
10	2
11	3
12	3
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 96.00	Costs = 70.50	Profits = 25.50
Competitor = 4	Revenue = 220.78	Costs = 167.70	Profits = 53.08

Objective Function: 2

Optimal Location = -3.00 -4.00
Value of the Objective Function = 130.50
Unit Var. Costs = 9.50 Price = 12.00

Customer #	to Firm #
1	2
2	2
3	2
4	3
5	3
6	3
7	2
8	2
9	2
10	2
11	4
12	3
13	2
14	2
15	2

Competitor = 2	Revenue = 300.00	Costs = 187.00	Profits = 113.00
Competitor = 3	Revenue = 84.00	Costs = 63.00	Profits = 21.00
Competitor = 4	Revenue = 36.00	Costs = 38.50	Profits = -2.50

FIGURE 7 (cont'd)

Objective Function: 3

Optimal Location = 4.00 -2.00
Value of the Objective Function = 398.80
Unit Var. Costs = 9.00 Price = 12.60

Customer #	to Firm #
1	2
2	2
3	2
4	3
5	3
6	4
7	2
8	2
9	4
10	2
11	3
12	3
13	4
14	4
15	2

Competitor = 2	Revenue = 204.00	Costs = 131.00	Profits = 73.00
Competitor = 3	Revenue = 96.00	Costs = 70.50	Profits = 25.50
Competitor = 4	Revenue = 126.00	Costs = 100.00	Profits = 26.00

Objective Function: 4

Optimal Location = 3.00 2.00
Value of the Objective Function = 220.78
Unit Var. Costs = 8.30 Price = 11.62

Customer #	to Firm #
1	4
2	4
3	2
4	3
5	3
6	4
7	4
8	4
9	4
10	2
11	3
12	3
13	4
14	4
15	2

Competitor = 2	Revenue = 96.00	Costs = 68.00	Profits = 28.00
Competitor = 3	Revenue = 96.00	Costs = 70.50	Profits = 25.50
Competitor = 4	Revenue = 220.78	Costs = 167.70	Profits = 53.08

FIGURE 8

Persistent Multi-stage Reactions to a Persistent Profit Max. Entry

Competitor 1	Competitor 2	Entrant	Stage
-4/-4	2/3	--	0
-4/-4	2/3	3/2 (obj. fn: 1)	1
-4/-4	2/2 (obj. fn: 1)	3/2	2
-4/-4	2/2	1/1 (obj. fn: 1)	3
-4/-4	2/1 (obj. fn: 1)	1/1	4

FIGURE 9

Non-persistent Multi-stage Reactions
to a Non-persistent Profit Max. Entry

Competitor 1	Competitor 2	Entrant	Stage
-4/-4	2/3	--	0
-4/-4	2/3	3/2 (obj. fn: 1)	1
-4/-4	2/2 (obj. fn: 1)	3/2	2
-4/-4	2/2	4/-2 (obj. fn: 3)	3
-4/-4	1/1 (obj. fn: 3)	4/-2	4
-4/-4	1/1	4/-2 (obj. fn: 3)	5

Firms' Standing at Equilibrium

(Competitor 2 Coded as: 4)

Customer #	to	Firm #
1		4
2		4
3		4
4		1
5		1
6		3
7		4
8		4
9		3
10		4
11		1
12		4
13		3
14		3
15		4

Competitor = 1	Revenue = 84.00	Costs = 66.00	Profits = 18.00
Competitor = 3	Revenue = 126.00	Costs = 100.50	Profits = 25.50
Competitor = 4	Revenue = 181.44	Costs = 141.60	Profits = 39.84

FIGURE 10

Persistent Multi-stage Reactions
to a Non-persistent Profit Max. Entry

Competitor 1	Competitor 2	Entrant	Stage
-4/-4	2/3	--	0
-4/-4	2/3	3/2 (obj. fn: 1)	1
-4/-4	2/2 (obj. fn: 1)	3/2	2
-4/-4	2/2	4/-2 (obj. fn: 3)	3
-4/-4	3/-2 (obj. fn: 1)	4/-2	4
-4/-4	3/-2	1/1 (obj. fn: 3)	5
-4/-4	2/1 (obj. fn: 1)	1/1	6
-4/-4	2/1	4/-2 (obj. fn: 3)	7

FIGURE 11

Two Alternative Entry Points

Competitor 1	Competitor 2	Entrant	Stage
-4/-4	2/3	--	0
-4/-4	2/3	3/0	1
-4/-4	2/0 (obj. fn: 1) or 2/3 (obj. fn: 3)	3/0	2
Competitor 1	**Competitor 2**	**Entrant**	**Stage**
-4/-4	2/3	--	0
-4/-4	2/3	3/-1	1
-4/-4	2/2 (obj. fn: 1) or 1/1 (obj. fn: 3)	3/-1	2

FIGURE 11 (cont'd)

Firms' Standing After Competitor 2 Locates at 2/2 After Entry at 3/-1

(Competitor 2 Coded as: 4)

Customer #	to Firm #
1	4
2	4
3	4
4	1
5	1
6	3
7	4
8	4
9	3
10	4
11	1
12	1
13	3
14	3
15	4

Competitor = 1	Revenue = 96.00	Costs = 74.00	Profits = 22.00
Competitor = 3	Revenue = 112.00	Costs = 90.50	Profits = 21.50
Competitor = 4	Revenue = 185.64	Costs = 144.60	Profits = 41.04

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